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JUDUL: DEVELOPMENT OF FLEXURAL STRUCTURE FOR CHATTER MACHINING TESTING

SESI PENGAJIAN: 2011/2012

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DEVELOPMENT OF FLEXURAL STRUCTURE FOR CHATTER MACHINING TESTING

MOHAMAD ALIF BIN MOHD NASIR

Report submitted in fulfillment of the requirements
for the award of the degree of
Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

JUNE 2012

UNIVERSITI MALAYSIA PAHANG
FACULTY OF MECHANICAL ENGINEERING

I certify that the project entitled "Development of Flexural Structure for Chatter Machining Testing" is written by Mohamad Alif Bin Mohd Nasir. I have examined the final copy of this project and in my opinion; it is fully adequate in terms of scope and quality for the award of the degree of Bachelor of Engineering. I herewith recommend that it be accepted in partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering.

(MIMINORAZEANSUHAILA BINTI LOMAN)
Examiner

Signature

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering.

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STUDENT'S DECLARATION

I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award for other degree.

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IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL

A special dedication of This Grateful Feeling to My…

Beloved parents, for giving me full of moral and financial support. It is very meaningful to me in order to finish up my degree's study. Do not forget also to my loving sister and last but not least to all my lovely lecturers and friends.

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ABSTRACT

This thesis deals with development of flexural structure that be used in detecting chatter on milling machine. The main important point in HSM is to increase MRR thus can reduce cost and increasing production. In this problem, chatter will limit the machining process and sometime will result in damage on cutting tool and surface roughness of material. The role of SDOF flexure is used as platform to perform stability test. It will provide a flexible workpiece with natural frequency. This project is carried out to develop a flexure with ability to be adjustable in height with natural frequency 400-600Hz. The process began using analytical method to identify the natural frequency. The simple calculation was carried out by determining the stiffness of the material. From the analytical method, at height of 13 cm the natural frequency was 424.82 Hz and 580.16 Hz at height of 11 cm. In this project, mild steel was used due to strength and toughness. After the calculation was done, the flexure was modeled using solidwork software and exported to Algor software for FEA. The analysis of flexure was done in order to verify the calculation before the flexure can be fabricated. From the result of FEA, at height of 13 cm the natural frequency reading is 415.23 Hz and 495.22 Hz at height of 11 cm. The flexure that fabricated fully then will enter the final stage to test with modal analysis. The frequency response of the flexure is determined by using impact hammer with giving force at load point and been measured by the accelerometer. The result shows at height 13 cm the natural frequency was 412.5 Hz and 562.5 Hz at height of 11 cm.

ABSTRAK

Kajian ini adalah mengenai pembangunan struktur lenturan yang akan digunakan untuk mengesan kehadiran gegaran pada mesin giling. Perkara utama dalam kepantasan permesinan adalah semasa kadar penyingkiran bahan seterusnya dapat mengurangkan kos dan meningkatkan produktiviti. Dalam pada itu, kehadiran gegaran telah membataskan proses permesinan dan kadangkala menghasilkan kerosakan pada mata pemotong dan permukaan bahan yang dipotong. Peranan struktur lenturan dengan darjah kebebasan tunggal digunakan sebagai pengalas sokongan dalam ujian kestabilan. Ia akan menyediakan satu bahan kerja yang fleksibal dengan nilai frekuensi semulajadi. Projek ini dijalankan bertujuan untuk membangunkan sebuah struktur lenturan dimana ketinggiannya boleh diubah dengan frekuensi semulajadi adalah antara 400-600 Hz. Projek ini bermula dengan menggunakan kaedah analisa pengiraan untuk menentukan nilai frekuensi semulajadi yang diinginkan. Satu jalan pengiraan mudah dilakukan untuk menentukan kekuatan bahan. Daripada pengiraan analisa yang dilakukan, didapati pada ketinggian 13cm nilai frekuensi semulajadi adalah 424.82 Hz dan 580.16 Hz pada ketinggian 11cm. Dalam projek ini, keluli lembut dipilih berdasarkan kekuatan dan keliatan yang terdapat padanya. Selepas pengiraan selesai dilakukan, struktur lenturan di reka menggunakan perisian solidwork dan dieksport ke perisian Algor untuk dianalisis unsur terhingga. Analisis kepada struktur lenturan dilakukan bagi menentukan ketepatan pengiraan analisa yang telah dilakukan pada awalnya sebelum struktur lenturan boleh di hasilkan. Daripada hasil keputusan analisis unsur terhingga, pada ketinggian 13cm bacaan frekuensi semulajadi adalah 415.23 Hz dan 495.22 Hz pada ketinggian 11 cm. Struktur lenturan yang telah siap dihasilkan kemudian memasuki fasa terakhir untuk diuji menggunakan modal analisa. Frekuensi balas oleh struktur lenturan dilakukan menggunakan tukul impak dengan diberikan daya padanya dan diukur menggunakan meterpecutan. Keputusan menunjukkan pada ketinggian 13cm nilai frekuensi semulajadi adalah 412.5 Hz dan 562.5 Hz pada ketinggian 11cm.

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LIST OF SYMBOLS

ω_n	Natural frequency
ζ	Damping ratio
k	Stiffness
I	Moment of Inertia
m	Meter
cm	Centimeter
mm	Millimeters
c	Damping constant
h	Height

LIST OF ABBREVIATIONS

MRR	Material removal rate
HSS	High Speed Machining
2DOF	Two degree of freedom
SDOF	Single degree of freedom
FEA	Finite Element Analysis
FEM	Finite Element Method
FRF	Frequency Response Function
FYP	Final Year Project

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

The main important point in high speed machining is to increase material removal rate (MRR). Consequently, it can simply reduce the production cost and increasing the production. The limitation in achieving MRR at high speed machining operations is instability behavior known as self excited vibration or chatter.

Chatter is a self-excited vibration caused by variations in instantaneous chip thickness. The tool begins to vibrate when flexible tool engages a workpiece because the vibrations are cut into the new surface leaving a wavy surface. The effect when the vibration of the cutting tool is out of phase with the previous surface makes the unstable cutting condition or chatter because of the variations in the instantaneous chip thickness. The workpiece or the tool will face with damage when large force vibrations during chatter.

However, the presence of chatter can be predicted by perform analytical stability to define stable and unstable condition for specific spindle speed and depth of cut. Figure 1.1 shows the unstable and stable cutting condition during machining process. Optimum machining aims to minimize the material removal rate while maintaining a sufficient a sufficient stability margin to assure the surface quality while avoiding chatter.

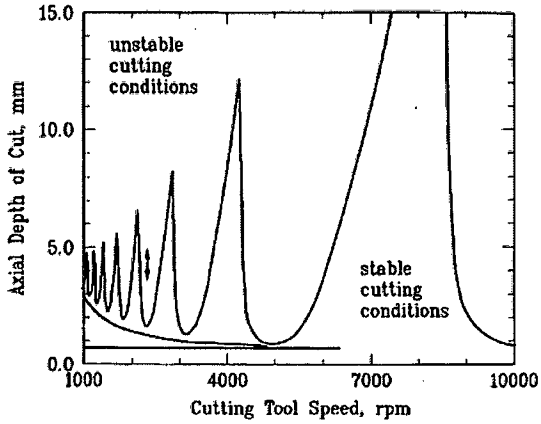

Figure 1.1: The cutting condition during machining process

Source: Daniel, 1997

It is important to minimize the undesirable motion of workpiece during high speed machining. There are several ways can be taken from the steps of mounting the workpiece to an active, supporting workpiece (flexure) and machining the workpiece. The undesirable motion of workpiece will be detected in the supporting structure then a reliable motion is applied to the flexural to minimize undesirable motion of workpiece.

1.2 PROBLEM STATEMENT

Usually designer or engineer will face a problem in increasing material removal rate in high speed machining which chatter will limit the objective. This project was carried out to develop the new flexure design which to investigate the self-excited vibration known as chatter. Stability test was predicted by mounting the workpiece to a single degree of freedom (SDOF) flexure.

1.3 OBJECTIVE

The objective of this project is to develop a single degree of freedom of flexural. The flexure design should can be operates to encourage undesirable motions of the workpiece independently of the machine tool devices. The design also should be adjustable in height in order to achieve the desired frequency in range of 400Hz - 600Hz. Firstly; analytical method was used to predict the natural frequency by determine the parameter of flexural. Then, FEA will simulate the flexural to validate the calculation been made earlier. Lastly, the modal analysis testing will perform to verify the natural frequency by applying force on flexural and measured the FRF of flexural.

1.4 SCOPE

This project required to develop a single degree of freedom of flexure. Below is scope in order to achieve the objective:

i. Search the literature review related to chatter and flexural during machining process.
ii. Make an analysis of advantages and disadvantages due to early invention of flexural.
iii. Develop a new design of flexural based on analytical solution with natural frequency range 400-600 Hz and Finite Element Analysis is used to simulate for verify the natural frequency of 400Hz - 600Hz.
iv. Verify the flexure with modal analysis testing using impact hammer.
v. Make a discussion and conclusion of experiment in a final report.

1.5 FLOW CHART

Figure 1.2 shows the project flow chart for this Final Year Project (FYP) 1. A first meeting has been arranged with the supervisor to discuss about the project title. This project required finding any related article, journal or references related to the project title. Then the proposal can be start to write containing introduction, literature review and methodology. The FYP1 will be ending with the presentation to the panel on week of 14^{th} on this semester seven.

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